

## Cosmic Chemistry: Planetary Diversity

## The Missing Planet

### TEACHER GUIDE

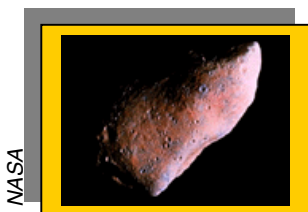
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#### BACKGROUND INFORMATION

The known planets are spaced fairly regularly around the sun, but there is an obvious gap between Mars and Jupiter. All the mathematical formulae for modeling the distances of the planets from the sun suggest that there should be a planet somewhere between 2.8 AU and 3.5 AU.

At this distance, however, we have found more than 4000 asteroids, with sizes ranging from over 900 kilometers to that of boulders. The largest of these solar system bodies, 1Ceres, is approximately 930 kilometers across and contains more than ¼ of the total mass of all the asteroids combined.

We think that most of the asteroids were planetesimals just like those that formed the nine planets, but something happened that caused their orbits to tilt and elongate. Because their collision velocities probably approached 5 km/sec, the asteroids fragmented each other rather than accumulating into a single body. The current total mass of these asteroids is probably less than half of the Earth's moon, which is  $7.35 \times 10^{22}$  kg or about 0.0123 of the Earth's mass.



As asteroids, they are cold, dead, and airless bodies, with their futures determined completely by outside forces. Their surfaces probably continue to be bombarded by micrometeorites, solar-wind particles and cosmic rays. During daylight the sun probably never warms them to temperatures exceeding 200 K.

The position of the asteroid belt in space is the transition point between the terrestrial planets and the large gaseous planets. This provides an interesting question to pose for students' consideration as the assessment activity of this *Planetary Diversity* module. The question certainly allows students to use their creativity as they compose their answers.

How much of the above information you provide for your students will be your decision, depending upon the age and background of your students. In addition to the planetary information furnished in this module's student texts, there are abundant resources on the topic of asteroids, both in print and electronic sources. Therefore, this assignment should include enough time for students to do an extensive literature search before formulating their answers to the specific questions posed in the Student Activity, "The Missing Planet."

#### STANDARDS ADDRESSED

##### Grades 5-8

##### Science As Inquiry

Abilities necessary to do scientific inquiry

##### Physical Science

Properties and changes of properties in matter

Motions and forces

Transfer of energy

Interactions of matter and energy

##### History and Nature of Science

Nature of science and scientific knowledge

## Grades 9-12

### [Science As Inquiry](#)

Abilities necessary to do scientific inquiry

### [Earth and Space Science](#)

Earth in the solar system

The origin and evolutions of the Earth system

Energy in the Earth system

### [Physical Science](#)

Properties and changes of properties in matter

Motions and forces

Transfer of energy

Interactions of matter and energy

### [History and Nature of Science](#)

Nature of science and scientific knowledge

(View a full text of the [National Science Education Standards](#).)

## MATERIALS

For each student

- Copy of [Student Activity, "Missing Planet"](#)

## PROCEDURE

1. Before class collect the materials necessary for the activity and make copies of the Student Activity, "Missing Planet"
2. During class distribute copies of the Student Activity, "Missing Planet"
3. Make sure that students understand that this is an assessment assignment and whether you intend that it should be done as individuals or as a team effort. In addition to a due date for the assignment, include the following:
  - a) The format for the completed assignment—which can be individual written descriptions of the planet, team written descriptions, poster displays, individual oral reports, team oral reports, or combinations of the above.
  - b) Information sources, which include not only the student texts from previous module activities but also print and electronic resources listed in this module or discovered during their literature searches.
  - c) The criteria that will be used to evaluate the assignment.